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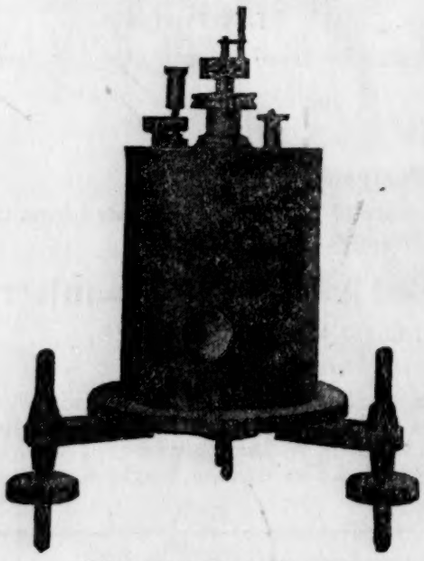

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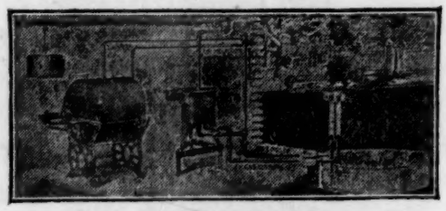

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PLANS FOR A HISTORY OF MATHEMATICS IN THE NINETEENTH CENTURY[1]

MY distinguished predecessor in the presidency of this association at one time ingeniously concocted a plan of procedure which if adopted, would have enabled him and succeeding presidents to escape the ordeal of preparing a presidential address. As a member of the council, I greatly enjoyed cooperating with others in nipping the president's scheme in the bud. Little did I know at that time that I was working against my own best interests and against the pleasure and comfort of the association on the present occasion.

An address being expected, it is my intention briefly to discuss plans of an organized movement for the writing of the history of mathematics of the nineteenth century on a scale commensurate with what has been achieved for previous periods. Taking for granted that such a history is desirable, in order that the present age may apprehend itself by comprehending its origin and growth, three important questions present themselves for consideration: Is it possible so early in the present century to write a satisfactory history of the preceding century? What will be the magnitude of the task, as compared with the labor involved in writing the earlier history? What should be the aim and nature of such a history?

As regards the first question, the material for the writing of modern scientific history is quite easily accessible. In this respect the writer of the history of science enjoys a great advantage over the writer of the history of recent diplomacy or war. Nor are the feelings and prejudices as intense on matters of

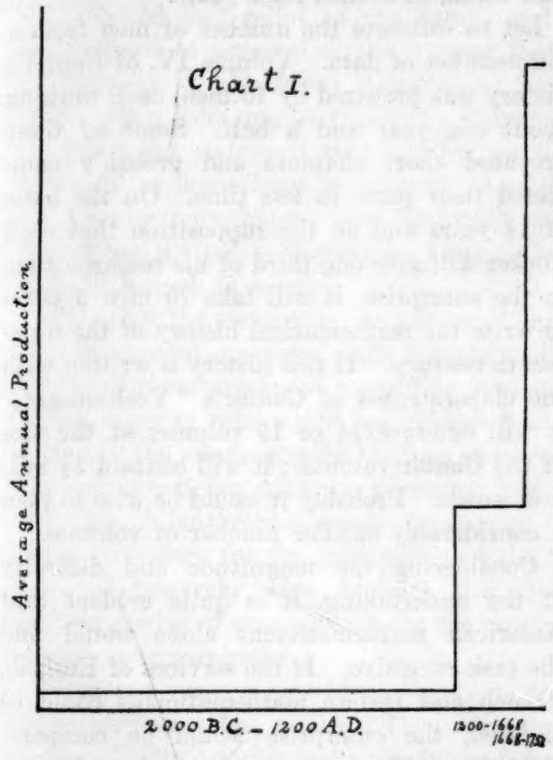
[1] Address delivered by Professor Florian Cajori as retiring president of the Mathematical Association of America, at Dartmouth College, on Saturday, September 7, 1918.

science as they are in religion, or in wars which involve the life and death of individuals and of nations. But, even if we have the material at hand, is it possible to write the mathematical history of the nineteenth century at this early date? Do we not now lack the proper perspective? In reply, we admit at once that we can not now write a history which will satisfy mathematicians seventy-five or one hundred years hence. All we can hope to do is to render a service to the present and the next generation of mathematical students and investigators. Nor can the history of the nineteenth century be written seventy-five or a hundred years from now in a manner that will be fully acceptable to all posterity. The general proposition holds true that no decade can write history which does not have to be rewritten later; no decade can write history for all future decades. There is an inevitable relativity of historical narrative. The reason for this relativity is obvious. The point of view changes; the attention of mathematicians will be directed to new concepts. Part of the history of mathematics will have to be rewritten in order to give proper emphasis to these new concepts. If it were possible, after the lapse of a few centuries, to impart finality to a history, then assuredly the history of Greek mathematics should have been rigidly determined and fixed long ago. But the facts disclose no such finality. In recent years the history of Greek mathematics has been partly recast. Zeno of Elea, whose arguments on motion formerly received little or no attention from mathematicians and were completely ignored by Montucla, the great eighteenth century historian of mathematics—this Zeno who was berated by philosophical writers as an insincere dialectician or as the progenitor of modern pettifogging lawyers—has been interpreted by Paul Tannery and other recent historians as having dealt sincerely and ably with questions of infinity now playing a leading rôle in modern mathematics. Geometric ideas of the last fifty years have brought into prominence the postulate of Eudoxus and Archimedes which the older historians of mathematics passed over in silence. The advent of the non-Euclidean geometry has thrown Euclid's parallel postulate into a wholly different light. Euclid's once criticized definition of equal ratios as contained in the fifth book of his Elements acquires a fresh interest when seen in the light of Dedekind's theory of the irrational. Many other illustrations might be cited to prove that historical narrative is relative, that history can not be written by a historian of one age, however keen, to satisfy all succeeding ages. Since this is so, should historians in despair drop their pens, remain idle and permit mathematicians to labor without the stimulus and light which a history of the modern developments of their science can give? Assuredly, no. A history of nineteenth century mathematics can be written acceptably to workers of to-day and to morrow, but will probably be in need of revision on the day after to-morrow. To wait for the moment when a history of mathematics can be written that will answer the demands of all future time is to postpone the crossing of a great river until all the water has flowed by.

An important step is the ascertainment of the magnitude of the task, the determination of the volume of mathematical literature to be penetrated. For purposes of comparison we have found it convenient to consider the mathematical productiveness during seven periods. Moritz Cantor's four volumes of lectures on the history of mathematics furnish the data for the first four periods. Statistics which I gathered from the first three volumes of Poggendorff's "Biographisches Handwörterbuch" were used to characterize the next two periods, while Professor H. S. White's "Forty Years' Fluctuations in Mathematical Research"[2] that took place since 1870 furnished the figures for the last period. Cantor's first volume gives the history of about 32 centuries down to 1200 A.D.; the second volume covers 468 years, to 1668; the third volume gives the history during 90 years, to 1758; while the fourth volume is limited to 41 years and carries the history down to 1799. We shall assume that the sizes of the volumes are ap-

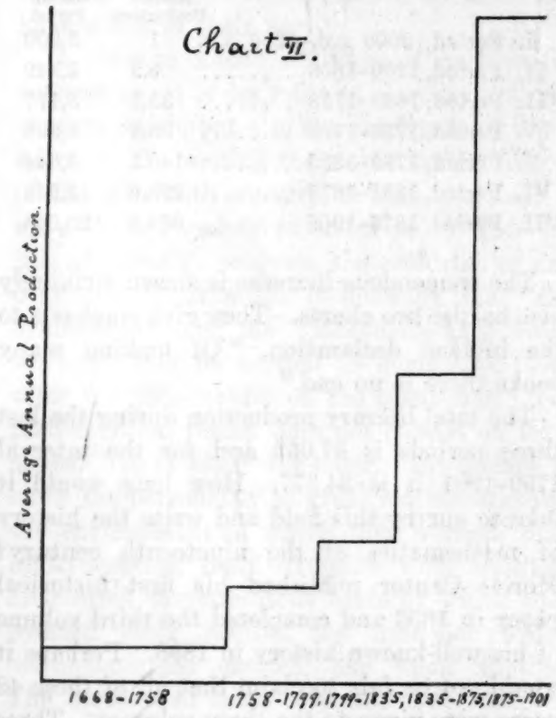
[2] Science, N. S., Vol. 42, 1915, pp. 105–113.

proximately proportional to the mathematical output of the periods covered. In Chart I., letting a short ordinate represent the average annual mathematical production during the first period extending from antiquity to 1200



A.D., we find that the average yearly production for the second period of 468 years is 6.9 times greater than for the first period, and for the third period of 90 years, 35.3 times greater. It will be convenient to take the average annual output during the first period as a unit measure of mathematical production. Accordingly, the figures for the first three periods are per annum, respectively, 1, 6.9, 35.3.

That we may graph more conveniently the expansion of mathematical literature since 1758, the third period is represented in Chart II. by a short ordinate. The fourth period of 41 years shows that the annual publications are 2.7 times more voluminous than those of the third period, indicating a yearly production of 95.8. To carry the comparison down to later periods I counted the number of mathematical writers given in the first two volumes of Poggendorff's "Handwörterbuch" for the eleven years 1790–1800. I found this number to be 244. For the period 1830–1840 I obtained 341 names. This indicates an increase in the ratio 1.398. I also counted the number of lines taken up in the enumeration of titles of books and articles of 134 mathematical writers for 1790–1800 and of 134 mathematical writers for 1830–1840. I began at random with the name of Jolly and in succession took the names of mathematical authors who wrote during these intervals. By this test the average productiveness of the individuals of these two groups proved, to my surprise, to be nearly the same; it was in the ratio of 1:1.04 in favor of the later group.



Combining the ratios of 1.398 and 1.04 I get 1.45 as the rate of increase in volume of mathematical literature of the period 1830–1840 over that of 1790–1800. The gradient fixed by the middle points of the third and fourth periods in Chart II. indicates for 1799 an approximate production of 114.4. Multiplying 114.4 by 1.45 gives 165.9 as the production for the year 1835. The average of 114.4 and 165.9, or 140.1 is the average annual production during the fifth period.

For the eleven years 1870–1880 I found in the third volume of Poggendorff 888 names

of mathematical writers; this number is 2.6 times greater than that for 1830–1840, indicating an annual production of 2.6 times 165.9 or 431.3. The average annual production for the sixth period 1835–1875, is the average of 165.9 and 431.3, or 298.6.

From Professor White's statistics it appears that the annual output was in 1905 about 2.1 times greater than in 1875, or 905.8. From these data it follows that during the seventh period, 1875–1905, the average yearly quantity of mathematical literature was 668.8. Our results, put in tabular form, are as follows:

	Average Annual Production	Production during Period
I. Period, 2000 B.C.–1200 A.D.	1	3,200
II. Period, 1200–1668	6.9	3,149
III. Period, 1668–1758	35.3	3,177
IV. Period, 1758–1799	95.8	3,928
V. Period, 1799–1835	140.1	5,044
VI. Period, 1835–1875	298.6	11,944
VII. Period, 1875–1905	668.8	20,064

The tremendous increase is shown strikingly also by the two charts. They give emphasis to the biblical declaration, "Of making many books there is no end."

The total literary production during the last three periods is 37,052 and for the interval 1799–1901 it is 34,377. How long would it take to survey this field and write the history of mathematics of the nineteenth century? Moritz Cantor published his first historical paper in 1856 and completed the third volume of his well-known history in 1898. Perhaps it would not be fair to claim that all of these 42 years were given to the three volumes. Three smaller historical books from his pen preceded the three volumes in question. The early years were years of necessary preparation. The first volume appeared in 1880, the second in 1892, or 12 years later. If we assume that the preparation of the first volume required the same time as that of the second, then 30 years is the time Cantor devoted to the three volumes. In the tabular view given above the first three volumes are the history covering mathematical material amounting to 9,526. At this rate it would take a man 108.3 years, or 20 men 5.4 years, to write the history of mathematics of the nineteenth century, provided that these men gave, as did Cantor, a liberal amount of time to research and confined their efforts to this particular project. If only one third of their research time were given to it, then 65 men would be needed for 5 years.

Let us estimate the number of men from a different set of data. Volume IV. of Cantor's history was prepared by 10 men, each working about one year and a half. Some of these prepared short chapters and probably completed their parts in less time. On the basis of 1½ years and on the supposition that each worker will give one third of his research time to the enterprise, it will take 79 men 5 years to write the mathematical history of the nineteenth century. If this history is written with the elaborateness of Cantor's "Vorlesungen," it will embrace 14 or 15 volumes of the size of the Cantor volumes; it will contain 5½ million words. Probably it would be wise to plan a considerably smaller number of volumes.

Considering the magnitude and difficulty of the undertaking, it is quite evident that American mathematicians alone would find the task excessive. If the services of English, French and Italian mathematicians could be enlisted, the enterprise would be comparatively easy. In past years it has been Europe that has initiated organized efforts among scientists. In proof of this I need only mention the "Encyklopädie der mathematischen Wissenschaften," the "Encyclopédie des sciences mathématiques," the "Royal Society Catalogue of Scientific Papers," as also the publications of Euler's complete works, of the *Fortschritte der Mathematik*, of the *Revue semestrielle*. It would seem to be our turn to take the initiative. The history of mathematics of the nineteenth century might very well be planned and financed by America. The magnitude and difficulty of the task would exert a healthful stimulus upon our 550 colleges and universities. Such an ambitious scheme would require the exercise of energies now latent.

Let us hope that the places where mathematical research is carried on will cease to be limited to a small number of localities on the

great map of our country—the seats of our stronger universities. The spirit of research should penetrate many other institutions. Young men of ability, now doomed to pass their lives with broken wings through the crushing weight of excessive hours of teaching, should find relief in the future and be encouraged to accomplish the highest that is in them to do. Professor Bjerknes, of Stockholm, when lecturing at Columbia University, ventured the statement that had his teaching schedule at home been as onerous as is that of American professors, then he would never have been invited to lecture in America in a difficult branch of science.

To carry the enterprise we are considering into successful operation calls for the united efforts of three groups of men: The mathematician, eager to enter a rich but difficult field of research, the administrator, willing to provide the mathematician with the necessary leisure, and the philanthropist, ready to supply the funds necessary for the publication of the results of research. Has America the ideals and the genius of organization for the creation of such a triumvirate?

In recent years a new ideal for the history of mathematics has arisen. The new movement calls for a much more careful and comprehensive scrutiny of historical material; it demands higher standards of historical accuracy. This ideal has been championed in the *Bibliotheca Mathematica,* a journal edited by Gustav Eneström, of Stockholm. According to the standards set by Eneström, the labors of Moritz Cantor, of Heidelberg, especially the third volume of his well-known history, hardly reach the high mark of excellence demanded. Cantor worked diligently and persistently for many years until finally failing eyesight lessened his powers and, more recently, compelled him to enter the darkened universe of the blind. If his third volume is inferior to his first two, an additional cause thereof is found in the fact that in the seventeenth and eighteenth centuries so many new mathematical subjects were introduced that the task of setting forth their history almost transcended the powers of a single individual. Necessity compelled the fourth volume to be prepared on the cooperative plan, by a group of men.

The present danger is that, in the effort to attain extreme accuracy in historical detail, we shall lose sight of literary quality. The publications of Huxley and Tyndall have demonstrated that scientific writing admits of combination with literary finish. The two ideals are not incompatible. Good literary form challenges attention and provokes admiration. Macaulay, the great master of words, made history enjoyable to thousands who otherwise would have shunned historical reading. Arago's biographies of scientific men have a charm their own.

In order to make the history of mathematics interesting, it is desirable to consider not only literary finish, but also the amplitude of topics selected. In writing the mathematical history of the nineteenth century, it does not seem to me sufficient merely to endeavor to trace the line of scientific progress, the evolution of new concepts. That much is done by the "Encyklopädie" and the "Encyclopédie," which we hope may be carried to completion soon after the termination of the great war. The mathematical reader does not subsist on logic alone. He is eager for color. He desires to know the personality of great mathematicians, the environment in which they worked, their idiosyncracies, their struggles with scientific difficulties, the circuitous route by which they reached their results, the influence which mathematicians exerted, one upon another. The heroism of some scientific men makes a tremendous appeal to the reader. These topics create not only interest but enthusiasm. In fact, if we consult our experience, as well as that of others, we are forced to admit that the best that we have from history is the enhusiasm which it generates. The mathematician, like the warrior, is a hero worshipper. In the case of Archimedes, the reader expects the historian not only to state accurately the connection of the writings of Archimedes with those of his predecessors, the advances that he made and the relations that his writings bear to the modern mathematics,

but the reader expects also a presentation in vivid style of the imagination and enthusiasm that Archimedes exhibited in the saying "Give me a fulcrum on which to rest, and I will move the earth;" the reader likes to be entertained by the narrative of his behavior when the true solution of the problem of the crown flashed on his mind—how he jumped out of his bath and shouted "I have found it"; the reader likes to be able to cite as marks of high patriotism his services to his sovereign in the construction of war engines and his alleged use of reflecting mirrors to set the Roman ships afire; the reader wishes to be reminded of the tragic death of Archimedes at the hands of a Roman soldier whom he had requested not to spoil his circles drawn in the sand, of his desire that the figure for his theorem on the sphere and circumscribed cylinder be inscribed upon his tomb, and how, over a century later, Cicero found the tomb of this the greatest mathematician of antiquity almost hidden amongst briars near one of the gates of Syracuse and forgotten by the people of the city.

Details of this sort do not strictly belong to a history of scientific ideas, but they add color to the narrative. Like all men, the mathematical reader is largely dominated by feeling. A modern poet has said of Horace,

> It is a curse
> To understand, not feel thy lyric flow,
> To comprehend, but never love thy verse.

Where is the science which appeals to the intellect alone, never to the heart? Such a science, if it exists at all, can not be found in the camp of the mathematicians. Certainly, then, the history of mathematics should appeal to the heart as well as to the head. Such a history should create respect and love for mathematics; it should excite admiration for this science; it should make the mathematician feel stronger than ever that he is contributing his bit toward the true grandeur of nations.

Florian Cajori
University of California

THE BRITISH NATIONAL PHYSICAL LABORATORY

The National Physical Laboratory is now conducted as a government institution under the financial control of the Committee for Scientific and Industrial Research, though its scientific work and researches remain under the direction of the Royal Society as before, and its annual report, of which the London *Times* gives an abstract, is for the first time published by the Stationery Office (2s. 6d. n.). As has been the case since 1914, a large part of the laboratory's work last year was in connection with the requirements of the war, and therefore can not be described in detail, even if referred to at all, but there is a considerable body of investigations to which this limitation does not apply.

In the electrical department additional magnetograph 24-hour records were taken and coincidences found between the running of electric trains on the London and South-Western Railway and magnetic disturbances at the laboratory. The question as to the magnitude and cause of certain of the disturbances was submitted to the arbitration of Mr. A. J. Walter, K.C., in November and December, and he adjudged that the use of electrical power by the railway has caused an increase in the horizontal magnetic field at the laboratory to an extent exceeding that stipulated in the South-Western Railway Act of 1913.

Among general electrical measurements a large number of the small mica condensers used in magnetos were tested for capacity and power factor; much work was done in connection with the composition and treatment of steel used for compass needles, and some special search coils proved valuable in testing permanent horse-shoe magnets. Some investigation was also made of the properties of non-magnetic steels. Sensitive vibration galvanometers for frequencies of the order of 10 cycles were constructed, and some preparations made for a research on effective resistance at radio frequencies. A new 400-volt secondary battery is being installed for use with large valves to generate the high-frequency current.

In the division of electrotechnics, in view of

the fact that large gas-filled lamps cause considerable heating of the lamp sockets used with them, owing to conduction of heat from the bulbs, measurements were made of the temperature rise of ventilated and unventilated sockets, and of the leading-in cables when used in lanterns of both the open and the enclosed types. It was found that the cables were liable to a total temperature of about 140° C., and that little improvement resulted from the use of existing arrangements for socket ventilation.

Good progress was made with the research on buried cables. The electrical constants of all the cables under test were determined, and it was found that in general the rise of temperature of a cable drawn into a stoneware duct was twice that of a similar cable armored and laid direct in the ground, cables laid solid in bitumen occupying an intermediate position. Other points, such as the length of time required by the cables to attain their maximum temperature, the effect of the ends, and the temperature gradient in the duct and in the cable, were also dealt with. The design of the special motor-generator set which will be used to supply continuous current for the cables, and which will also be used for heavy test work, has been settled and the machine is under construction. It consists of two continuous-current generators, each fitted with two commutators. Each commutator is arranged for a current of 1,250 ampères at 6 volts, the ends being brought to a series-paralleling board. By this means currents up to 1,250 ampères at 24 volts will be available for the cable tests and up to 5,000 ampères at 6 volts for the test work, suitable regulation to any required current being obtained by resistances in the exciting circuits. The generators, which will be driven by a three-phase 3,000-volt motor running off the town supply, will be separately excited, the excitation current being maintained constant by a centrifugal spring regulator putting resistance into or out of the field of the motor.

The heat division collaborated with the Heating and Cooking Panel of the Engineering Standards Association in developing efficiency tests for electrical plates and cooking stoves. A number of pyrometer sheaths of British manufacture were tested for their softening point and porosity at high temperature. Some of the samples of porcelain, though unglazed, stood the porosity test remarkably well; in fact, when the interior was exhausted to a pressure of a few millimeters of mercury the walls collapsed under the external pressure before any leakage occurred. On the other hand, tubes of fireclay and shrunk alumina often showed a return to atmospheric pressure in about 10 seconds. A large series of aluminium alloys was investigated for thermal conductivity on behalf of the Light Alloys Sub-committee of the Advisory Committee for Aeronautics, the advantages of such alloys, on account of their high conductivity, for the construction of the cylinders and pistons of aero engines having been appreciated for some time. It was evident at the outset that measurements at room temperature would not be sufficient, since the temperatures encountered in actual practise range up to 300° C., and an absolute and expeditious method of determining thermal conductivity and its variation with temperature was therefore devised.

In Metrology the year was distinguished by the development of the gauge-testing work. The new gauge-testing building was completed in May, and occupied in the early part of June. The numbers dealt with, however, continued to increase and at the end of 1917 were more than double those of 1916. There was a steady increase in the quantity of screw gauges tested, but in the first three months of this year there was a considerable reduction in gauges of the more simple types. The types that continue to be received are, however, in general more complicated and involve more work in testing than those which have dropped out. The gauge-rectifying shop was found much too small to meet the demands made upon it, and the erection of a new workshop of 10,000 square feet area was sanctioned. The building of this has been started.

Arrangements have been made for the calibration of glass volumetric apparatus. Accom-

modation for the work will be provided in a new three-story building to be erected alongside the Administration Building, but meantime a house close to the laboratory entrance is being equipped temporarily for the purpose.

A watch sent for testing by Paul Ditisheim, La Chaux de Fonds, Switzerland, obtained 96.2 marks out of a possible 100—the highest total yet recorded in the Kew trials.

The investigations of the methods of notched bar impact testing were continued, and in the present year it is proposed to inquire into the following questions: Need for test bars of different sizes; the question of test bars supported at two ends or fixed at one end; how far the work of fracture depends on the cross-section or the volume of the test bar, or both, and whether a relation can be found for reducing results on one size of bar to those on another; influence of the velocity of striking and angle of bend of the bar; and application of notched bar tests to carbon steels in industrial products. The hardness test research is being extended to cover the effect of the wear caused by sliding abrasion, of variations in the relative velocity of the surfaces, and of the pressure between them. The Brinell ball test, usually adopted for indicating the indentation hardness of a material, is open to the objection that it varies with the load and with the hardness of ball used. Hence a standard ball of 10 mm. diameter and a fixed load of 3,000 kg. are employed, but it is not always possible to use this standard—*e. g.*, with very thin test pieces or very soft materials. Experiments have therefore been made with the object of studying the various methods of bringing results obtained with different balls and loads into line with those obtained by using the standard.

The experiments with the apparatus described in last year's report for determining the heat transmission to water from the internal surfaces of brass pipes, smooth and roughened, were completed. The results showed that, with the amount of roughening obtained, the heat transmission per unit surface per degree in difference of temperature between metal and water for the smooth pipe could be increased in the ratio of about 2.5 to 1 for the same mean velocity of flow. It was obvious that if improvements of this order could be made in the surfaces of air-cooled engines and radiators, considerable economy of material could be effected in aeroplane engine design. To test the question a series of copper gills of the form and distribution commonly adopted in air-cooled engines was fixed to the cylinder of the engine and set up in a wind channel. An electric current was then circulated through the gills, and from measurements of the current and resistance it was possible to ascertain the temperature of the gills and the heat dissipated. The gills were first tested in their ordinary smooth condition and then roughened by means of corrugated steel dies. The roughening, however, appeared to produce practically no effect on the heat transmission, this result indicating that the convection of momentum to the rough and smooth surfaces was approximately the same. The reason for this apparent discrepancy between the two sets of observations is still under investigation.

The demands of the Aerodynamics Department are so numerous and important that the erection of two new air channels has been called for. A new airscreen balance for the 7 foot tunnel is in hand and a new apparatus for lift measurement is in use. Modified apparatus for the measurement of rotary derivatives was devised and will be further developed.

The research work carried out was of the most varied character. Tests were made on models of aeroplane wings, monoplane and biplane models of complete aeroplanes, airships and kite balloon models, and models of airscrews, with calculations relating to stability, strength of construction, bomb-dropping, etc. A large amount of work was done in connection with the design of wind channels, and the research on eddy motion was continued. Many of the investigations were made in response to direct requests from the Air Ministry, but every effort was made to increase the value of special tests by bringing them into proper relation as part of an organized scheme of research.

Such increase in equipment as was made in the Metallurgy Department arose chiefly in connection with the extension of foundry facilities urgently needed for the work on light alloys and on optical glass. The investigation on aluminium and other light alloys was energetically pursued and was devoted to the immediate requirements of aircraft construction. A considerable amount of theoretical investigation was also carried on, leading to the establishment of a number of constitutional models of ternary alloys of aluminium with other metals. A number of important practical questions were thus cleared up, among them being the explanation of the various forms in which silicon is found analytically in aluminium alloys and the bearing of these results on the properties of the materials. Other researches had for their object the elucidation of apparently anomalous behavior in various groups of aluminium alloys. The nature and constitution of the more important ternary alloys and the influence of impurities on them were investigated, with the result that these relationships are now much better understood.

A large amount of research and investigatory test work was carried out on steel. Some of the results obtained seem to be of wide importance in regard to the treatment to which particularly thick boiler plates can be safely subjected. Research on magnetic steels was actively continued. Investigation was begun of a set of specially made tungsten steels of graded composition, received from Messrs. Thomas Firth and Sons, but it was found necessary to adopt better methods of magnetic measurement than were used in the earlier stages of the work, and special arrangements were also made for carrying out thermal observations of these steels in a more satisfactory manner. A number of discrepancies were revealed, believed to arise from the influence which antecedent thermal and mechanical treatment of the steel exercises on its subsquent magnetic behavior. To clear up these questions, which are of vital importance in the production of satisfactory magnets, and which involve questions affecting steels other than the particular tungsten alloys under investigation, a special research was initiated for the study of the constitutional relations of iron-carbon-tungsten within the range of alloys concerned.

The work in connection with the proposed issue of standardized steel samples to serve as standards for the chemical analysis of steels was carried forward in conjunction with a committee of the Iron and Steel Institute, but was hampered by existing conditions. It is hoped however, that the issue of standardized samples may become possible shortly.

As regards optical glass a large amount of work was done in preparing pots or crucibles of special refractory materials that do not lend themselves to treatment by ordinary methods. Methods of melting and stirring glass were further investigated by means of experimental meltings, some of which gave results of great promise.

The testing of ship models for firms in the experimental tank was affected in two ways. First, the building of fast and intermediate liners being in temporary abeyance, there was no demand for model work with those types of vessel. Second, the introduction of standard vessels must result in the suppression of individuality in the forms adopted by different builders, and the model results for one firm will apply to all vessels of the type, no matter where built. It is therefore the more important that steps should be taken to ensure that whatever forms are adopted as standard shall be good ones. Private firms have recognized this, and about half the vessels tested for firms during the year were in connection with standardization. The best result obtained was a reduction of 13 per cent. in resistance without any variation of displacement or dimensions, or diminution of working qualities such as stability. Apart from tests for private firms a number of models of standard cargo vessels were made and tested for the Admiralty and others. There were a number of tests with straight line forms of fabricated ships, and the satisfactory results obtained must lead to an extension of the use of this type if it is found to be constructionally acceptable.

SCIENTIFIC EVENTS

THE STUDENTS' ARMY TRAINING CORPS

In a letter from the War Department addressed to the colleges of the United States, August 28, 1918, the general plans under which the Students' Army Training Corps will operate this year were outlined. Among the most important statements were the following:

1. All young men, who were planning to go to school this fall, should carry out their plans and do so. Each should go to the college of his choice, matriculate and enter as a regular student. He will, of course, also register with his local board on the registration day set by the President. As soon as possible after registration day, probably on or about October first, opportunity will be given for all the regularly-enrolled students to be inducted into the Students' Army Training Corps at the schools where they are in attendance. Thus the Corps will be organized by voluntary induction under the Selective Service Act, instead of by enlistment as previously contemplated.

The student, by voluntary induction, becomes a soldier in the United States Army, uniformed, subject to military discipline and with the pay of a private. They will simultaneously be placed on full active duty and contracts will be made as soon as possible, with the colleges for the housing, subsistence and instruction of the student soldiers.

2. Officers, uniforms, rifles and such other equipment as may be available will be furnished by the War Department, as previously announced.

3. The student-soldiers will be given military instruction under officers of the Army and will be kept under observation and test to determine their qualification as officer-candidates, and technical experts such as engineers, chemists and doctors. After a certain period, the men will be selected according to their performance, and assigned to military duty in one of the following ways:

(*a*) He may be transferred to a central officers' training camp.

(*b*) He may be transferred to a non-commissioned officers' training school.

(*c*) He may be assigned to the school where he is enrolled for further intensive work in a specified line for a limited specified time.

(*d*) He may be assigned to the vocational training section of the corps for technician training of military value.

(*e*) He may be transferred to a cantonment for duty with troops as a private.

4. Similar sorting and reassignment of the men will be made at periodical intervals, as the requirements of the service demand. It can not be now definitely stated how long a particular student will remain at college. This will depend on the requirements of the mobilization and the age group to which he belongs. In order to keep the unit at adequate strength, men will be admitted from secondary schools or transferred from Depot Brigades as the need may require.

5. No units of the Students' Army Training Corps will, for the present, be established at secondary schools, but it is hoped to provide at an early date for the extension of military instruction in such schools. The secondary schools are urged to intensify their instruction so that young men seventeen and eighteen years old may be qualified to enter college as promptly as possible.

6. There will be both a collegiate section and vocational section of the Students' Army Training Corps. Young men of draft age of grammar school education will be given opportunity to enter the vocational section of the corps. At present about 27,500 men are called for this section each month. Application for voluntary induction into the vocational section should be made to the local board and an effort will be made to accommodate as many as possible of those who volunteer for this training.

Men in the vocational section will be rated and tested by the standard Army methods and those who are found to possess the requisite qualifications may be assigned to further training in the collegiate section.

7. In view of the comparatively short time during which most of the student-soldiers will remain in college and the exacting military duties awaiting them, academic instruction must necessarily be modified along lines of direct military value. The War Department will prescribe or suggest such modifications. The schedule of purely military instruction will not preclude effective academic work. It will vary to some extent in accordance with the type of academic instruction, *e. g.*, will be less in a medical school than in a college of liberal arts.

8. The primary purpose of the Students' Army Training Corps is to utilize the executive and teaching personnel and the physical equipment of the colleges to assist in the training of our new armies. This imposes great responsibilities on the colleges and at the same time creates an exceptional opportunity for service. The colleges are asked to devote the whole energy and educational power of the institution to the phases and lines of training de-

sired by the government. The problem is a new one and calls for inventiveness and adaptability as well as that spirit of cooperation which the colleges have already so abundantly shown.

THE EPIDEMIC OF SPANISH INFLUENZA

IN an effort to prevent an epidemic of Spanish influenza throughout the United States, Surgeon-General Blue of the Public Health Service has provided a list of methods for the control of the disease. From a telegraphic survey made by General Blue it was discovered that the disease had broken out in six United States seaport towns, Fort Morgan, near Mobile, Ala.; Newport News, Philadelphia, New York, Boston, New London and New Orleans.

Dr. Blue's bulletin of information on the disease issued primarily for physicians, contains information as follows:

Infectious Agent—The bacillus influenza of Pfeiffer.

Sources of Infection—The secretions from the nose, throat and respiratory passages of cases or of carriers.

Incubation Period—One to four days; generally two.

Mode of Transmission—By direct contact or indirect contact through the use of handkerchiefs, common towels, cups, mess gear or other objects contaminated with fresh secretions. Droplet infection plays an important part.

Period of Communicability—As long as the person harbors the causative organism in the respiratory tract.

Methods of Control—The infected individual and his environment.

Recognition of the Disease—By clinical manifestations and bacteriological findings.

Isolation—Bed isolation of infected individuals during the course of the disease. Screens between beds are to be recommended.

Immunization—Vaccines are used with only partial success.

Quarantine—None; impracticable.

Concurrent Disinfection—The discharges from the mouth, throat, nose and other respiratory passages.

Terminal Disinfection—Thorough cleansing, airing and sunning. The causative organism is short-lived outside the host.

General Measures—The attendant of the case should wear a gauze mask. During epidemics persons should avoid crowded assemblages, street cars and the like. Education as regards the danger of promiscuous coughing and spitting. Patients, because of the tendency to the development of broncho-pneumonia, should be treated in well-ventilated, warm rooms.

SAN FRANCISCO JOINT COUNCIL OF NATIONAL ENGINEERING SOCIETIES

FIVE national engineering societies which have San Francisco sections on September 4 organized what is to be known as the Joint Council of the Engineering Societies of San Francisco. The societies represented are the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the American Chemical Society. Four representatives from each of these societies, making twenty men in all, form the joint council, which in turn is officered by an executive committee of five. The members of this executive committee are: C. D. Marx, chairman; E. C. Jones and E. C. Hutchinson, vice-chairman; N. A. Bowers, secretary-treasurer, and E. O. Shreve, assistant secretary.

We learn from the *Electrical World* that this organization is the outcome of several meetings of the secretaries of the five societies involved at which plans for more effective inter-society cooperation have been worked out. Some of the expected advantages are a closer touch among members of the several associations, putting the several employment bureaus together in one central office, joint meetings to discuss subjects of common interest, cooperation for the sake of economy as in mailing notices, consolidating headquarters at the Engineers' Club, etc.

In a paper on this subject read at a recent joint meeting it was pointed out that membership in a national engineering society has always carried with it a certain amount of prestige. Here in the Far West we have been content with little besides that as a return for our annual dues. In recent years local sections have taken on new importance, and it is not now uncommon to find the man who believes he can get more real benefit from his

local section than from the national organization.

Our parent societies have joined in forming the United Engineering Society, and the plan has proved eminently successful from every angle. May we not begin now to lay the foundation for branches of that organization in western centers? Why not the San Francisco branch of the United Engineering Society? At least we may suggest this as an ultimate possibility, another incentive among the opportunities that await our pioneer joint council.

The joint council will have regular meetings once a month, the executive committee convening at the pleasure of its members. The constitution tentatively adopted at the September 4 meeting sets forth the following as the purposes of the organization:

1. To foster closer relationship among the engineering societies of San Francisco, especially in those matters (*a*) where cooperation will make for more efficient "win the war" service, (*b*) where cooperation will make for more efficient service to the state of California, its cities and counties, and (*c*) where cooperation will expedite progress toward those ideals common to our several organizations.

2. To plan and carry out arrangements for joint meetings of the several societies whenever such meetings are deemed advisable and to endeavor to make joint meetings effective in developing closer relationships among members of the several societies.

3. To act generally as the clearing house for matters which involve the several societies, especially where the common good will be enhanced by working through an executive head representative of the several organizations.

The first act of the joint council was the decision to urge upon the governor of the state the appointment of an engineer as member of the state railroad commission. In making this recommendation it was pointed out that "the best interest of the state would be served by the appointment of engineers as members of commissions dealing with problems the solution of which requires technical training and experience" and that the appointment of an engineer to fill one of the vacancies on the state railroad commission would doubtless "be regarded by the people of the state as indicating a wish to place the public service on the highest plane of efficiency and will be creditable both to the appointing power and to the engineering profession."

CHEMISTS AND THE CHEMICAL WARFARE SERVICE

Major General William L. Sibert, director of the Chemical Warfare Service, addressed, on September 1, the following letter to the chemists of the United States:

This is a chemical war: therefore the War Department must have immediately available all possible information regarding chemical materials and chemical man power. Of these two essential elements chemical man power has so far received less attention. The census of American chemists made by the American Chemical Society in 1917 has been of great assistance to the War Department. Without it the present state of progress of the United States in chemical warfare would have been impossible of attainment.

However, during the same period conditions have undergone rapid and radical changes. The old census, excellent as it was, is no longer completely adequate. With the organization of the Chemical Warfare Service as an independent branch of the War Department, unifying all the elements of chemical warfare, it is obvious that the War Department must have its own set of records on a matter so vital to its own success. Moreover, these records must contain information which a short time ago was apparently of little importance. The new census must be made primarily from the viewpoint of the military status of chemists.

The importance of a prompt return of the census blank, properly filled out, by every chemist of the country, can not be overstated. American chemists are presented at this moment with one of the greatest opportunities to serve their country by the simple process of answering this questionnaire with all possible speed.

It is stated in the *Journal of Industrial and Engineering Chemistry* that as a result of the letter from the Adjutant General of the Army, dated May 28, 1918, 1,749 chemists have been reported on. Of these the report of action to August 1, 1918, shows that 281 were ordered to remain with their military organization

because they were already performing chemical duties, 34 were requested to remain with their military organizations because they were more useful in the military work which they were doing, 12 were furloughed back to industry, 165 were not chemists in the true sense of the word and were, therefore, ordered back to the line, and 1,294 have been placed in actual chemical work. There were being held for further investigation of their qualifications on August 1, 1918, 432 men. The remaining 23 men were unavailable for transfer, because they had already received their overseas orders. Each case has been considered individually, the man's qualifications and experience have been studied with care, the needs of the government plants and bureaus have been considered with equal care, and each man has been assigned to the position for which his training and qualifications seem to fit him best.

SCIENTIFIC ORGANIZATIONS OF THE ALLIED NATIONS

AT the invitation of the Royal Society, a conference between representatives of the Allied nations will be held in London on October 9 to discuss the future conduct of scientific organizations. According to *Nature* it is expected that representatives from the academies of Paris, Rome, Tokyo and Washington, as well as nominees of the governments of Belgium, Portugal and Serbia, will attend. A memorandum proposed by a committee of the Royal Society points out that international scientific organizations and conventions may be divided into four groups, according to their objects and methods of procedure. A first group consists of those important agreements which fix the standards of measurements, and are essential not only in purely scientific investigations, but also in the development of many industries. A second group contains associations definitely formed for the investigation of scientific problems in which coordination of observation is essential. A third group, which hitherto has not been large in numbers, but presents some special features, embodies the efforts to organize undertakings that might be carried out in one locality, but is more economically dealt with by a division of work. The most prominent example of this type is the arrangement made between eighteen observatories to form a photographic chart of the heavens. The organization dealing with the "International Catalogue of Scientific Literature" may also be included in this group. In the fourth group is placed the large number of congresses called together by workers in some one department of science, and mainly intended to foster friendly personal relationships between those who pursue similar aims in different countries. There is, finally, in a group by itself, the International Association of Academies, which aims at coordinating the activities of international undertakings, and organizes work for which special permanent bodies do not exist and are not required. The council of the Royal Society will submit the following questions as subjects for discussion at the forthcoming conference: (1) Is it desirable for the Allied nations to establish organizations for scientific cooperation among themselves? (2) If this be agreed upon, what should be the particular forms of organization to be aimed at in geodesy, seismology, meteorology, etc? (3) Should particular academies be asked to submit proposals on those undertakings in which they have taken the leading part, such as: (*a*) The Académie des Sciences on the Commission Métrique and the Bureau International des Poids et Mesures; (*b*) The Royal Society on the International Catalogue of Scientific Literature? (4) What representations should be addressed to the governments with regard to those organizations which have hitherto received their support? The conference at present is intended to deal only with scientific subjects, but similar questions no doubt also arise on the literary side.

SCIENTIFIC NOTES AND NEWS

SAMUEL WENDELL WILLISTON, professor of paleontology in the University of Chicago, has died at the age of sixty-two years.

MAXIME BÔCHER, professor of mathematics in Harvard University, has died at the age of fifty-one years.

Mr. John O'Connor, Jr., one of the assistant directors of the Mellon Institute of Industrial Research of the University of Pittsburgh, has gone to Washington to assume the duties of civilian appointment in the Plan and Scope Division of the Quartermaster General's office.

Professor Miles S. Sherrill, of the department of chemistry, Massachusetts Institute of Technology, has been granted a leave of absence from the institute and has commenced work on explosives for the Ordnance Department.

Dr. Creelman, commissioner of agriculture in Ontario and president of the Ontario Agricultural College, has left for England, where he will consult with the directors of the University of Vimy Ridge, with respect to the agricultural training of soldiers.

Dr. F. Mollwo Perkin has been elected president and Mr. H. A. Carwood secretary of an association of chemists engaged in the oil and color and allied trades which has been organized in England.

The John Wimbolt prize in civil engineering at Cambridge has been awarded to Mr. E. B. Moullin, B.A., of Downing College, formerely of Newcroft School, Bournemouth, for an essay on "Some problems of gaseous explosions."

The Moxon medal of the Royal College of Physicians of London has been awarded to Dr. F. W. Mott.

Dr. A. S. Pearse, of the University of Wisconsin, has returned from a trip to Maracay, Venezuela, where he studied the fishes of Lake Valencia.

Professor C. M. Smith, of the department of physics, Purdue University, spent the summer in scientific work at the Bureau of Standards, Washington, D. C.

Dr. E. C. Shorey, in charge of the division of chemical investigation in the Bureau of Soils, U. S. Department of Agriculture, has resigned to accept a position with the National Aniline and Chemical Co., Inc., at Marcus Hook, Pa.

Odell E. Lansing, assistant botanist in the Field Columbian Museum, died by suicide on September 11, aged fifty-one years.

M. Charles Joseph Etienne Wolf the distinguished French astronomer, died on July 4, at the age of ninety years.

Mr. W. M. Crowfoot, of Beccles, Suffolk, who died on April 6 at eighty years of age, bequeathed a collection of exotic butterflies and moths to his wife for life and then to the Natural History Museum, University College, Nottingham; a collection of shells from the Paris basin, his cragshells, and other fossils to the Norwich Museum; a collection of shells from the Italian Pliocene basin and a collection of marine, land and fresh-water shells to the Ipswich Museum.

Since the establishment of the *Journal of Geography*, formerly the *Journal of School Geography*, over twenty years ago, the magazine has been under personal management and control. During the first thirteen years Professor R. E. Dodge of the Teachers College, New York, carried most of the responsibility. During the last eight years the present editor Professor Ray Hughes Whitbeck, of the University of Wisconsin, has carried the major part of that responsibility. During the past summer, the American Geographical Society of New York offered to take over the complete ownership and control of the *Journal* and the offer has been accepted. During the remaining four months of 1918, the present editorial and business management will continue.

The autumn meeting of the Institute of Metals was held in the rooms of the Chemical Society, London, on September 10 and 11. We learn from *Nature* that among the communications submitted were: The Resistance of Metals to Penetration under Impact, including a note on The Hardness of Solid Elements as a Periodic Function of their Atomic Weights, Professor C. A. Edwards; Grain Growth in Metals, Dr. Z. Jeffries; Rapid Recrystallization in Deformed Non-ferrous Metals, Mr. D. Hanson; The Influence of Impurities on the Mechanical Properties of Admiralty Gunmetal, Mr. F. Johnson, and A Peculiar

Case of Disintegration of a Copper-Aluminium Alloy, Dr. R. Seligman and Mr. P. Williams.

THE Società italiana per il Progresso delle Scienze, the head offices of which are in Rome, has issued, as we learn from *Nature*, the program of the tenth meeting, which is to be held in Pisa on October 16–19 under the presidency of Professor Ferdinando Lori and the secretaryship of Professor Vincenzo Reina. The success of the meetings at Rome in 1916 and at Milan and Turin in 1917 has convinced the council that it will be interpreting the wishes of the members in continuing even in war-time to maintain its activity in promoting the advancement of knowledge in the country. Mathematics, physics, chemistry and aeronautics do not figure in the proceedings of the sections, which are to be devoted mainly to geological and mineralogical papers in Class A, biological and medical in Class B, and economical in Class C. It is the object of the meeting to pay a large amount of attention to the study of the mineral resources of Italy. At the same time the Italian Thalassographic Commission is organizing a subsection of Class B on fisheries, and is presenting an annual report, while similar reports are being presented by the Glaciological Committee and the National Commission for the Development of Scientific and Industrial Progress. The Italian Association for the Study of Building Materials is to meet in Pisa at the time of the congress. The opening meeting of the scientific gathering is to be held on October 16, at the university, when an inaugural address will be given by Professor Raffaello Nasini on "A proposal for an inventory of Italy's mineral wealth." In addition to the sectional meetings, nine general lectures have been arranged for the mornings of the subsequent days, while the sections will meet in the afternoons, and an excursion will take place on the Sunday.

The British Medical Journal states that the council of the Paris Medical Faculty has drawn up a report setting forth a number of reforms and extensions which it is proposed to make in the scope and methods of its teaching work. For the teaching of pathology cinematographic apparatus will be installed in the lecture theaters and collections of films are to be made. One of the two chairs of internal pathology is to be transformed into a clinic of infectious diseases. The practical curriculum is to be completed and supplemented by a large scheme of free clinical teaching in which all the members of hospital staffs who wish to do so will take part. With the object of ensuring almost full autonomy to the services of the faculty by securing the most favorable organization for the treatment of patients and the instruction of students a commission of studies has been set up which includes representatives of the Ministries of Public Instruction and of the Interior, the Prefecture of the Seine, the Municipal Council, the University, the Faculty and the medical staffs of the hospitals. Arrangements will be made for the purpose of attracting to Paris men of science, doctors and students from foreign countries. The government has favorably received a request that it should provide funds for the improvement of existing services and for the creation of others, particularly an institute of medical biology. Internal improvements have been made in the library and museums of the faculty. A special committee has been engaged in elaborating the statutes of a society of friends of the Paris Medical faculty.

THE *Journal of Industrial and Engineering Chemistry* states that the straits to which Germany has been reduced by the cutting off of oil supplies from outside has led to some remarkable discoveries or at least communications of discoveries. Professor R. France, of Munich, claims to have discovered a new source of oil in certain cryptogamic plants growing in Bavaria to which he has given the name "Esaphone." He calculates that by adding thereto certain other parasitic plants growing in Germany some 1,200,000 kilos of oil of excellent quality can be obtained per annum. As it does not congeal except at about 40° below zero, he suggests that it would be highly useful for aeroplanes and the engines of vessels going to arctic regions. Professor France

also states that by collecting the drops of resin which collect in spring upon felled pine and fir trees about 60 liters of oil could be secured from every cord of wood.

The Technical Department, Aircraft Production, of the Ministry of Munitions of Great Britain has prepared a detailed report on an example of the new German 300-h.p. Maybeck aero engine taken from a Rumpler biplane which was brought down in France in January last. These engines are described in the report as undoubtedly representing a great improvement in general design and efficiency as compared with the old 240-h.p. Maybach engines found in Zeppelin airships. The quality of the workmanship of every part, including the exterior finish throughout, is exceptionally good, and the working clearances are carried to very fine limits. Every part, nevertheless, shows the usual German characteristics of strength and reliability, combined with standardization and ease of manufacturing in preference to the saving of weight. The engine has six vertical cylinders with a bore of 6.5 in. and a stroke of 7.09 in., and weighs 911 pound complete with propeller boss and exhaust manifold, but without fuel or oil. On an hour's test, running at the normal speed of 1,400 rvolutions a minute, it gave on the average 290 b.h.p., the weight being thus a little over 3 pounds per h.p. The consumption of petrol was 0.55 pint and of lubricating oil 0.038 pint per b.h.p. hour. The C.4 type of Rumpler machine from which this engine was taken is a two-seater biplane designed for long-range artillery reconnaissance and photography. These machines are said to be generally flown at high altitudes—15,000 feet to 17,000 feet—until over the lines, and from French reports the 300 h.p. Maybach engines are more flexible and regular in running than the 260-h.p. Mercédès engines generally fitted in them. Their armament consists of one Spandau gun fixed in front of the pilot's seat and firing through the propeller, and one swivelling gun mounted in the observer's seat behind.

UNIVERSITY AND EDUCATIONAL NEWS

At a meeting of the General Municipal Council and the Chamber of Commerce at Bordeaux on September 10, the proposal to establish in honor of the President of the United States a Franco-American university of applied sciences, commerce and industry was unanimously adopted.

The Birmingham Metallurgical Society has planned to award scholarships at Birmingham University to technical school students in metallurgy. The purpose is to assist boys who otherwise would be unable to afford a university training in metallurgy.

Dr. H. C. McNeil, associate chemist in the Bureau of Standards, has been appointed acting professor of chemistry in George Washington University, Washington, D. C., succeeding Dr. Charles E. Munroe, who assumes the chairmanship of the committee of explosives investigations under the National Research Council.

William C. Morse, of Washington University, St. Louis, has been elected professor of geology at the Mississippi Agricultural and Mechanical College.

Professor Owen W. Mills, formerly of Westminster College, has been appointed professor of biology at Middlebury College.

DISCUSSION AND CORRESPONDENCE

DUAL QUEENS IN A COLONY OF HONEY BEES

During a recent visit, June 3–6, 1918, to the Massachusetts Agricultural College at Amherst, Mass., by the courtesy of Dr. B. N. Gates I was given the unusual opportunity of accompanying him on his inspection of the forty colonies of the bee yard.[1]

It has so frequently been stated that two queens are rarely found in one colony of honey bees that the occurrence of two queens, evidently mother and daughter, living side by side

[1] In addition to many interesting facts of honey bee behavior, I was able to collect material for a morphological study of the developmental stages of the three castes of honey bees. I am deeply grateful to Dr. Gates for his assistance and kindness in securing my material.

in an apparently peaceful condition, seems worthy of note.

The colony in which the dual queens were found is colony 95 of the Massachusetts Agricultural College Bee Yard, and the data in regard to its history were given me by Dr. Gates, with whose permission these notes are published.

On May 23, 1918, Dr. Gates had inspected this hive and found only the old queen. No queen cells were present and the colony was of medium strength, occupying only one story of the hive. The queen was introduced to this colony on August 1, 1917, and was therefore not old, and came of strong stock which had been selected for four years to resist the European foulbrood.

Thirteen days later, on June 5, 1918, on opening the hive a large number of queen cells was first noted; there were seven in all, three cells containing eggs, one a larva about four days old, two with young pupæ, and one empty cell with its cap thrown back, showing that a queen had recently emerged. The varied ages of the developing queens in these cells was interpreted by Dr. Gates as indicative of a tendency towards "supersedure," that is, the replacement of the old queen by a new one.

After a short search, a young virgin queen was found on the comb, her appearance showing that she had only emerged a few hours before. On another comb the old queen was found laying. Her wings were slightly frayed, although she was less than a year old, and her abdomen was considerably larger than that of the virgin queen.

In normal cases of "supersedure" the parent queen is destroyed by the workers prior to the emergence of the virgin, and in swarming it is known that the parent queen leaves the hive on the day that the cell of the new queen is capped.

Such a case of "supersedure," with the survival of both parent and daughter queens in the same colony, suggests a return of the probable ancestral condition of multiple queens, the condition that prevails to-day among bumble bees in the late summer, among certain wasps, and in ants.

After the discovery of the dual queens in a single colony, the old queen with most of the brood was confined in the second story of the hive, with a "queen excluder" above the first story, in which the virgin queen was placed with one sheet of brood and nine empty combs. The subsequent history of the old or parent queen may explain why her workers attempted to supersede her.

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PARAMECIA WITH EXTRA CONTRACTILE VACUOLES

THREE years ago I found a race of *Paramecium caudatum* which possessed more than two contractile vacuoles. A preliminary note on the behavior of these vacuoles was published in this journal (1915, Vol. 42) and two years later an account of the morphology, physiology and genetics of this new race appeared in the *Journal of Experimental Zoology* (1917, Vol. 23). In this paper the following conclusions were presented:

1. The number of contractile vacuoles range from two to seven. Three- and four-vacuoled forms are most abundant.

2. Apparently any individual has the potentiality for higher numbers of vacuoles. The appearance of the vacuoles depends on two things —(*a*) the rapidity of division; rapid fission does not give time for the vacuoles to form, (*b*) the amount of catabolic waste in the environment. If the percentage of waste is relatively high the average number of contractile vacuoles in the paramecia of the culture is high. In new cultures made up with fresh hay infusion the average number of vacuoles is low. The effect of rapidity of division can be partially overcome, since old cultures in which the rate of fission has been increased through the addition of new food show an average vacuole number much higher than found in fresh infusions.

3. Although several generations may pass without the appearance of extra vacuoles the potentiality for these organs is inherited and merely waits for the proper (apparently environmental) conditions to call them forth.

4. The extra vacuoles are, in almost all

cases, located in the posterior half of the animals. In a few individuals one extra vacuole was found in the anterior end.

5. It was tentatively suggested that this new character might have been the result of heat, as the animals in the original culture had been used in temperature experiments.

The last statement now seems doubtful, for since the appearance of these papers I have heard from other investigators of similar paramecia being observed in widely separated parts of the country. They have been reported in Wisconsin, Indiana, Massachusetts and Connecticut. Those discovered in Indiana possessed either three or four vacuoles.

This note was prepared in hope that attention might be attracted to the vacuole numbers so that more data on this variation may be obtained. The possession of extra contractile vacuoles makes this race of paramecia exceedingly important, not only because it is a variation of the common type but because the sensitive response of the vacuole number to changes in the environment may make these individuals useful as indicators in certain classes of experiments.

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MATHEMATICAL INSTRUCTION AND THE WAR

In view of the evident desirability of establishing a central agency for the gathering and dissemination of information pertaining to mathematical instruction in relation to the war, the *American Mathematical Monthly* is opening a new department, entitled "Collegiate Mathematics for War Service." Any reader of Science in possession of suitable information is urged to send it in at once. If the information is of sufficient importance, and in the opinion of the editorial staff of the *Monthly*, delay in publication might greatly diminish its value, preprints will be made for the earliest possible distribution. Already preprints of several articles dealing, in the main, with mathematical training for naval service, are in the course of preparation. The chief consideration relative to the new department is maximum possible service in our war program; other considerations, such as ideals of accuracy, completeness and scholarship must be regarded as secondary. Suggestions for making the new department as useful as possible will be welcome from all quarters.

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QUOTATIONS

SCIENCE AND THE CIVIL SERVICE

The great technical developments of the nineteenth century, which were due in a large measure to the influence and progress of science, have undoubtedly introduced not only a great transformation in the internal affairs of the country, but also an altered outlook in the external relations of the state. In consequence, many and extensive have been the changes gradually brought about, during the past century, in the duties and responsibilities of the civil service. Every government department has been affected to some extent; in some of them there have come into existence innovations which are of a very far-reaching character. The outstanding feature of this evolution is that the work of government departments has to-day entirely ceased to be of a purely administrative order, whether it be in relation to legislative measures referred thereto for preparation, revision, or criticism, or to the operations conducted therein, or to the sphere of human activity superintended, controlled, or managed thereby. The business of every government department is to-day to some extent technical or scientific; in the case of some departments the administrative aspect predominates; in others it is the technical or scientific aspect that plays the more important rôle.

What, then, has the state done to ensure that the personnel of the civil service, through whom its responsibilities must be largely exercised, shall be properly qualified and equipped for dealing, under present-day conditions, with the social, industrial and commercial problems which must come before it for legislative, executive, or other action?

One important step has been taken in relation to this matter: it has been definitely laid down that candidates for the civil service shall, before appointment, be required to undergo some test as to their knowledge and capacity. To give effect to this decision the Civil Service Commission was, by an order in council dated May 21, 1855, appointed to organize a system of examination; the Commission continues to be charged to the present day with the duty of providing suitable candidates for the public services. In 1870 the principle of open competition was introduced for the purpose of filling certain specified situations in the civil service, without, however, entirely abolishing "patronage" appointments. Afterwards, in 1876, the clerical establishment of the civil service was divided into a higher and a lower division; in 1890 the name "lower division" was altered to "second division," and a provision introduced making it possible for a "second division" clerk to be promoted to a higher division clerkship. It is the clerical establishments of the civil service which have alone received attention in the foregoing legislation.

Obviously, it is on the complete success of the competitive examination scheme in force that the welfare of the civil service, and, therefore, the protection of the public interest, must depend. It is here that a serious failure has occurred; the open competitive scheme has not been an entire success; it has been productive of a very unfortunate result. The system of marking adopted in the examination favored candidates whose education consisted largely in the learning of ancient Greece and Rome, and handicapped those whose *forte* was science.

Furthermore, in practically every case the officials who have in recent years received "patronage" appointments in the higher division of the civil service are men whose education and training have been identical in character with those of civil servants entering the service by open competition. In consequence, at the present day the highest administrative posts in nearly every department are monopolized by men whose learning is entirely literary. Further, the technical officers—that is, those in whose education science has played the preponderating rôle, and on whose skill and knowledge the welfare of many of the public services very largely depends—are almost entirely excluded from a share in the important administrative posts; needless to say, much to the injury of the public services.

Could it be shown that a purely classical or literary education really tends to develop or to produce administrative talent in an individual superior to that which can be obtained by means of a scientific education and technical training, as is sometimes claimed, there might indeed be some excuse for the retention of the principle of selection adopted; but there is none in actual fact. There exists, on the contrary, abundant evidence to prove conclusively that administrative talent is no exclusive privilege or quality of those who have received a purely classical or literary education: the names are familiar, in wide circles, to high and low, of men who have proved themselves capable administrators of the highest order; men, possessing the capacity of a Cromer or of a Kitchener, in whose education instruction in science also occupied a very prominent place; men whose early years were, too, spent in technical spheres.

The opinion has been gaining ground for some time past that the administrative system of government departments is unsatisfactory. The extracts from the reports of the Exchequer and Audit Department published from time to time, wherein publicity is given to the defects in the administrative arrangements in connection with the public services, have provided, in relation to such matters, authentic evidence tending to confirm, in the public mind, the unfavorable opinions that prevail so widely as to the unbusinesslike methods of the civil service and the general lack of capacity shown by a large majority of its members. Other authentic evidence is available—some recorded, some not; some public property, some not—which provides an indication that scientific knowledge and technical experience are held in disrepute in many, happily not in all, government

departments; and, further, that the professional opinions of technical officers too frequently are not given the due weight which they deserve. Science has done much for the civil service; it has not, in return, received the recognition which it merits.—*Nature.*

SCIENTIFIC BOOKS

The Physical Chemistry of the Proteins. By T. Brailsford Robertson. New York, Longmans, Green and Co. Pp. 483. $5.00.

The limiting adjective "physical" might be omitted from the title of Robertson's new edition, so completely does it cover the field of protein chemistry. Part I., including the first third of the book, is devoted to the chemical constitution of the proteins, their preparation, methods of estimation, and the various types of compounds which they form with each other and with acids, bases, salts, heavy metals, etc. Part II. is devoted to the electro-chemistry of the proteins; Part III. to their physical properties, such as gelatinization, swelling, coagulation, viscosity and surface tension, not included under Part II.; and Part IV. to the hydrolytic and synthetic actions of enzymes on proteins. Throughout the work statements and discussions are placed on a quantitative basis by the use of mathematical treatment wherever data sufficiently complete and accurate to justify it are available. Biological applications are kept continually in view. Despite the fact that he covers so wide a field and thoroughly reviews the literature, the author seldom fails to augment the interest of his material by presenting it from a view-point developed from his own experimental and intellectual researches.

Donald D. Van Slyke

SPECIAL ARTICLES

UNLIKE REACTION OF DIFFERENT INDIVIDUALS TO FRAGRANCE IN VERBENA FLOWERS

In classifying the floral colors in a certain pedigree of verbenas, the writer noticed a considerable difference in the amount of fragrance evident in their flowers. Some plants appeared to have flowers devoid of odor while the flowers of others were strongly fragrant. One with pale pink flowers, which may be called plant *A*, was especially pleasing in this respect. In showing it to my assistant, Mr. B. T. Avery, Jr., I remarked that it should be called an arbutus verbena since the flowers resembled the arbutus in both color and odor. To my surprise he failed to find any fragrance at all in the flowers of this plant. Moreover, when he arranged the pedigree according to the strength of fragrance which they gave to him it was roughly in the reverse order from that in which I should have arranged them. The most fragrant of all to him was a red-flowered plant the flowers of which to me were absolutely without fragrance. This for convenience we may call plant *B*. The flowers of plant *B* then were fragrant to him but not to me while those of plant *A* were fragrant to me but not to him. Each of us agreed that the other's favorite had a very slight odor that could be best described as a leafy or plant odor which apparently was the same as that of the foliage. Moreover, he described the fragrance from plant *B* as of a spicy nature resembling that from a carnation flower to which I am not insensible, while the fragrance of plant *A* seemed to me to closely resemble that of arbutus, with which he is also familiar. It did not seem to be the case that we both perceived the same odors but, having different preferences, dignified the one which we liked with the term fragrant. Rather the facts indicated that he was insensible to the odors in the flowers of *A* while I was insensible to odors in those of *B*. We repeated the tests many times under various conditions with the same results. He never was able to perceive any fragrance from *A* while, except upon a few occasions when I detected a slight odor such as he had described, I was unable to find any fragrance in his favorite.

In addition to ourselves, others in the community were tested for their reaction to fragrance in our plants *A* and *B*. The later tests were made in October. Due perhaps to the lateness of the season or to other conditions, the few remaining flower clusters then produced by plant *A* were not always fragrant.

In making the tests, an *A* flower cluster that was fragrant to me was used in contrast with a *B* flower cluster that was adjudged fragrant by Mr. Avery or by one who had been found to react to it in the same manner in which he did. The person to be tested was asked to decide which of the two was the more fragrant. There was an amusing uniformity in the manner of response. The subject would generally say he feared he was not smelling well that day, would then blow his nose and almost at once pick out either *A* or *B* and wonder how any one could think the other fragrant. When questioned as to fragrance in the flowers that were not preferred, he would generally say they were not fragrant but had a slight odor variously described as being a plant odor or an odor like a dead leaf.

The pleasure obtained from odors is often closely bound up with other associated perceptions. For this reason, in some cases the individuals tested were asked to smell the flowers with their eyes closed. Color associations were shown to have no controlling influence in the reaction. In some instances the tests were repeated but without affecting the results.

Of the men, 17 preferred the flowers of *A* while 9 preferred those of *B*—a ratio of 2 to 1. Of the women, 9 preferred *A* while 4 preferred *B*. In general the results were clear-cut and the individuals tested found fragrance in one of the two flowers and not in the other. A few, however, found a slight fragrance in the flowers that they did not prefer and two women found fragrance in both and could not decide between them.

Flowers from the two plants were exhibited at a staff meeting of the Carnegie Station and were repeatedly smelled by the seven members present. Five found fragrance in A and not in *B* and two showed a reversed reaction.

It is a trite proverb that in matters of taste there can be no argument. The assumption is that though we differ in our preferences, our perceptions are essentially the same. In the case of the verbena flowers under discussion, however, it has been shown that preferences of different individuals in regard to fragrance are based upon radical differences in their perception of odors. The condition suggests color-blindness, but those who are color-blind react to both of two colors when they are unable to distinguish between them. About two thirds of the individuals tested with the verbena flowers were "blind" to odors in the flowers of plant *B* while perceiving odors in *A*. On the other hand, about one third were "blind" to odors in *A* while perceiving odors in *B*. It is as if my black looked white and my white, black to Mr. Avery and his group; while from his viewpoint, I and the group that agreed with me were equally distorted in our vision.

It is well known that people differ considerably in their ability to hear tones of higher musical pitch. Many can not hear the notes of the cricket. Other insects produce sound vibrations of so high a pitch that they are inaudible to any human ear, though perceived by related insects. The peculiarity in the perception of the verbena fragrance might resemble the individual peculiarities in the powers of hearing if it were true that a large group of people could hear the extremely high musical notes and not the lowest tones while another group could hear the lowest and not the highest.

The acts brought out in the foregoing discussion furnish an added example of the difficulty in classifying characters studied in inheritance. A group of different individuals in investigating fragrance in our pedigree of verbenas would be classifying their own olfactory perceptions as well as the actual odors in the flowers. It is well for us to recognize the limitations of the personal equation. Discrepancies in conclusions reached by different investigators may not be due to any fault in logical reasoning or to lack of intellectual honesty. Their diverse conclusions may be inevitable, given only differences in their sensory reactions and in their mental experience.

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THE WHITE-SPOT DISEASE OF ALFALFA

FOR a number of years the writer has observed the white-spot disease of alfalfa, par-

ticularly in the middle-western, intermountain and Pacific Coast states. Usually this disease is not considered serious by alfalfa growers, but in many instances the writer has noted that the disease may be more or less disastrous and may produce a very decided loss in yield. During the last few years particular attention has been paid to this disease because of its very great prevalence in the intermountain states. In the Salt Lake Valley, Utah, this disease has been considered by many of the farmers as being due entirely to the smoke from the smelters. However, the writer has found it to be quite as serious in districts far removed from the Salt Lake Valley where soil and climatic conditions are the same. Because of the importance of the disease the writer has made some studies of which a preliminary report is given below.

Reference to the literature indicates that very little has been done to determine the real cause of the disease. The earliest reference to the disease is that by Stewart, French and Wilson.[1] These authors indicate that they believe this disease to be due to a physiological disorder of some kind. The next references are by Reed & Crabill[2] and by Clinton.[3] The most recent reference is by Crabill,[4] who believes that white spot is due to the wounding of the tissue of the crowns of the plants. His experiments indicate that by cutting away a portion of the tissues the typical white spot was produced. The occurrence in nature, he believes, is due to the fact that the injury to the plants is produced in the late fall or winter because of the fact that he has only observed the disease in the early spring. The wounding of the plants in cultivation, he believes permits the entrance of certain fungi which tend to rot the crowns and later the roots. Such plants, he has found, will show white spot in the early spring, shortly after the plants have started to grow. Recently, however, Crabill indicates (letter of April 17, 1918) that he did not always find a crown rot of the affected plants and he thinks that crown rot may, therefore, be only a circumstance and, after all, not the true cause.

In carrying out some experiments on the treatment of soils with various water-soluble substances, the writer, to his surprise, found that white spot suddenly appeared in a large number of the treated plots. Each plot covers an area of 25 square feet, composed of fifty plants from two to three years old. The plants have been very carefully cultivated with a hoe and the crowns have never been injured in any way. In general the white spot appeared within sixty to seventy hours after the soil had been treated. In no case did a single specimen of white spot appear in the check plots. Furthermore, white spot did not appear in any of the plots where the total water-soluble substance applied was below a certain amount. Further experiments indicated that the "soil solution" alone would not produce white spot, but that the factors of soil temperature, atmospheric temperature, relative humidity of the atmosphere and light are important. In other words, it requires a certain coincidence of these various factors at what we shall term the optimum before an effect was produced upon the plants such as would cause white spot to appear.

It may be stated here that the experimental plants are growing in a sandy-loam soil and at no time previous to the experiment had white spot appeared.

The work has progressed to the point where the writer believes that the osmotic pressure of the soil solution is one of the important factors in the production of white spot, not only under experimental conditions but under field conditions as well. With conditions for transpiration at the optimum, lessening or preventing endosmose, by reason of a soil solution having a higher osmotic effect upon the cells of the transpiring organs. The degree of injury produced will depend upon the factors enumerated above, together with the time factor which is all important. If these factors are

[1] "Troubles of Alfalfa in New York," by F. C. Stewart, G. T. French and J. K. Wilson, Bulletin No. 305, November, 1908, New York Agricultural Experiment Station, Geneva, N. Y.

[2] Va. Station Technical Bulletin, 2, 39, 1915.

[3] Conn. Sta. Report, Report of the Station Botanist, 1915, 425.

[4] *Phytopathology*, Vol. 6, No. 1, 1916, pp. 91.

coincident for a relatively short period of time only, a few white "spottings" at a distal end of the leaflets may result; if the time element is lengthened, all the cells of the leaflet may suffer a water loss much below the wilting coefficient, and instead of a "spotted" appearance the entire leaflet will bleach white. This is exactly what happens under both experimental and field conditions. In the intermountain country where a very large number of observations have been made, it has been noted that fields showing a considerable incrustation of alkali when irrigated exhibited white spot in more or less amount, depending upon the other environmental factors above mentioned. Also, a sudden rise of the water table in irrigated districts has brought about the same appearance of the plants in the fields. Some very interesting observations have been made on fields adjacent to each other, with plants of the same age and all conditions the same excepting the application of water. The irrigated fields showed extensive white-spot trouble, while the non-irrigated fields showed none.

It has been noted by eastern pathologists who have made observations on this disease that it occurs mainly in the spring of the year. However, the writer has observed it in the intermountain districts during the early spring, during mid-summer and during the late fall; in short, throughout the entire growing season.

Specimens of artificially produced white spot of alfalfa were submitted to several plant pathologists who reported that these specimens were identical with diseased alfalfa plants which they had themselves collected.

An extended report will be published in due time after the completion of certain experiments which are now in progress.

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THE POLYHEDRAL VIRUS OF INSECTS WITH A THEORETICAL CONSIDERATION OF FILTERABLE VIRUSES GENERALLY

IN a previous paper[1] J. W. Chapman and I called attention to the fact that the wilt or polyhedral disease affects many different species of insects. We also showed that the disease is not produced by bacteria, but is caused by minute organisms capable of passing through diatomaceous filters, and further attempted to demonstrate that the polyhedral bodies always found associated with the disease are not organisms, as supposed by Bolle, Fischer, Marzocchi and Knoche, but reaction bodies—simply nucleoprotein by-products.

In order to satisfy myself that we were really dealing with an organism and not merely with an enzyme, toxin or other material a large series of passage infections were instituted. Twenty-five gipsy moth caterpillars were infected at a dilution of 1:1,000 with material obtained from a caterpillar previously dead of wilt. The animal was merely ground up, sterile water added and the whole filtered through a sterile Berkefeld grade "N" candle. All twenty-five caterpillars fed with the filtrate died typically of wilt during the course of three weeks, whereas twenty-five controls fed with the autoclaved filtrate lived, pupated and transformed into moths. One animal dead in this first series was prepared, the material diluted as before (1:1,000), filtered and fed to another series of twenty-five caterpillars. The experimental animals all succumbed, whereas the controls did not. Third and fourth passage infections were performed and the results were similar with the exception that the period from infection to death was considerably shorter at the fourth passage than at the first three. This shortening of the time between infection and death seems to point towards an increase in virulence with successive passages.

There are certain autocatalytic substances like chromatin that increase progressively, so to the physiologists my passage infections may not necessarily be proof for the contention that I am dealing with parasitic ultra-microscopic organisms. However, if one reviews the field of the filterable viruses[2] and compares all of the results obtained by other workers with my results, one can not but feel inclined to

[1] *Biol. Bull.*, Vol. XXX., No. 5, pp. 367–390.

[2] Thirty-two diseases are now known to be caused by filterable viruses.

adopt the view that one is dealing with minute parasitic forms. Some of the filterable viruses (pleuro-pneumonia of cattle, fowl pest, fowl diphtheria, epithelioma contagiosum and Novy's rat disease) have been cultivated, so that the question as to whether we are dealing with organisms or not is solely an academic one. We are justified at present, however, in not classifying such viruses either with the plants or animals.

The table gives a summary of the chief characters of the wilt virus. The virus used in these tests was prepared from diseased gipsy moth, army worm and tent caterpillars. That proteins like gelatin and casein are not affected when treated with the filtrate in which the virus has been concentrated by centrifuging is curious because insect tissue is completely emulsified through the action of the wilt virus. This action is therefore probably a cytolytic one due to the action of toxins and is not caused by the elaboration of a proteolytic enzyme on the part of the virus.

In a physico-chemical explanation of the origin of organisms on our planet the filterable viruses seem to be of considerable interest and I do not understand why they seem to be so persistently neglected by all writers on the evolution of life. The filterable viruses probably realize Osborn's[3] "hypothetical chemical precellular stages"; they lie somewhere in the scheme between simple colloidal and more complex cellular states like bacteria. Some thirty-two or thirty-three disease-producing filterable viruses are now known to exist, so it is reasonable to assume that the earth, water and atmosphere are full of non-parasitic forms which we have no means of recognizing at present.

TABLE SUMMARIZING CHARACTERS OF POLYHEDRAL VIRUS OF INSECTS

1. Cultivation of virus	Has not been cultivated
2. Filtration of virus	Passes through Berkefeld "N" but not through Pasteur-Chamberland filter
3. Examination of virus with ultra-microscope.	Nothing visible that could be interpreted as being different from minute protein or pigment particles
4. Effect of heating on virus when suspended in water	Destroyed at 60° C. in 20 minutes
5. Effect of dry heat on virus	Destroyed at 70° C. to 80° C. in 20 minutes
6. Effect of drying on virus at room temperature.	Resistant for 2 years
7. Effect of glycerine on virus	Resists 98 per cent. for 6 months
8. Effect of direct sunlight on virus when dry	Resistant for 12 hours
9. Effect of putrefaction on virus	Resistant for an indefinite time
10. Effect of alcohol on virus	Destroyed by 80 per cent. in 15 minutes
11. Effect of carbolic acid on virus	Destroyed by 5 per cent. in 3 weeks.
12. Effect of virus on 1 per cent. sugar solutions	No growth, no fermentation
13. Effect of virus on methylene blue and sodium nitrate solutions	No growth, no reduction
14. Effect of virus on gelatin and casein	No growth, no liquefaction

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[3] "The Origin and Evolution of Life," by Henry Fairfield Osborn, Charles Scribner's Sons, New York, 1917, p. 80.

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